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Metropolitan Income Inequality and Working-Age Mortality: A Cross-Sectional Analysis Using Comparable Data from Five Countries

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ABSTRACT *The relationship between income inequality and mortality has come into question as of late from many within-country studies. This article examines the relationship between income inequality and working-age mortality for metropolitan areas (MAs) in Australia, Canada, Great Britain, Sweden, and the United States to provide a fuller understanding of national contexts that produce associations between inequality and mortality. An ecological cross-sectional analysis of income inequality (as measured by median share of income) and working-age (25–64) mortality by using census and vital statistics data for 528 MAs (population >50,000) from five countries in 1990–1991 was used. When data from all countries were pooled, there was a significant relationship between income inequality and mortality in the 528 MAs studied. A hypothetical increase in the share of income to the poorest half of households of 1% was associated with a decline in working-age mortality of over 21 deaths per 100,000. Within each country, however, a significant relationship between inequality and mortality was evident only for MAs in the United States and Great Britain. These two countries had the highest average levels of income inequality and the largest populations of the five countries studied. Although a strong ecological association was found between income inequality and mortality across the 528 MAs, an association between income inequality and mortality was evident only in within-country analyses for the two most unequal countries: the United States and Great Britain. The absence of an effect of metropolitan-scale income inequality on mortality in the more egalitarian countries of Canada, Australia, and Sweden is suggestive of national-scale policies in these countries that buffer hypothetical effects of income inequality as a determinant of population health in industrialized economies.*

KEYWORDS *Australia, Canada, Great Britain, Income inequality, Mortality, Sweden, United States.*

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INTRODUCTION

Research examining the hypothesis that an area's income distribution is linked to the overall health of its inhabitants has delivered mixed results over the past decade.[1–3] Following up on Rodgers' original international findings,[4] Wilkinson demonstrated that for a group of very wealthy countries, income inequality as measured by the share of income belonging to the poorest 70% of households was correlated with mortality but an absolute measure of income was not.[5] However, later studies have been unable to reproduce those results for a more expanded set of countries.[6] In the latter half of the 1990s and into the early 2000s, there were several studies linking income inequality and mortality within the United States, first at the state level,[7–10] and then at the MA level,[11,12] although the validity of these findings has been disputed by others.[1,13,14] Studies of Canadian provinces and MAs,[15] Japanese prefectures,[16] Copenhagen neighbourhoods,[17] and New Zealand regions[18] did not demonstrate statistical relationships between income inequality and measures of population health within those countries, but a recent study reported an association between area measures of income inequality and self-rated health in Britain.[19]

Urban income inequality may influence health through mechanisms which incorporate both traditional ideas of epidemiologic exposure as well as ideas about the long-term health effects of stress-inducing social comparison.[7,20,21] Highly unequal urban areas, especially those whose labour markets generate very disparate intra-metropolitan employment opportunities and working conditions, may amplify the well-established effects of low income and education on health status of populations. High urban income inequality, furthermore, provides the conditions for the spatial separation of affluence and poverty, which in turn, produces urban neighbourhoods with very different material and social bases for the production of human health.[22]

This article brings together comparable income distribution and mortality data on 528 MAs in five industrialized countries to: (1) examine the overall cross-national relationship between income inequality and mortality at the MA scale and (2) compare the strength of the association between income distribution and working-age mortality within each of the countries. Working-age mortality has been used as the outcome in past international comparisons of income inequality and mortality,[15] and mortality for working-age populations has been shown to be very sensitive to underlying social conditions.[23] We use an ecological research design with aggregate data and are aware of the possibility of the nonlinear individual level relationship between income and mortality producing artefactual findings.[24] Although this argument is logically true, Wolfson and colleagues[25] have shown that for US states, the artefactual explanation cannot account for the aggregate level relationship between income inequality and mortality. Metropolitan areas are the units of analysis given that urban areas are arguably a very relevant geographic scale for the examination of any population-health consequences of inequality.[6] Processes of social and economic differentiation caused by inequalities inherent in labour and housing markets are generally experienced by individuals at the metropolitan scale. In addition, health and social services are accessed locally and experiences of differences in consumption patterns are often most obvious at the scale of the MA.

Data Sources

The data for this analysis have been compiled to be as comparable as possible across the 528 MAs in the five countries. The minimum population size for the MA

to be included in this study was 50,000 in 1991 (1990 for the US MAs). The mortality data are the 3-year average death rates for the working-age population (25–64 years), centred around 1991 for Australia, Canada, Great Britain, and Sweden and 1990 for the United States. The mortality rates were age-standardized to the Canadian population in 1991. Income inequality was calculated as the share of total post-transfer, pre-tax household income held by the poorer 50% of all households within a given MA. This measure has been used in a previous international comparative context[15] and a study examining the relationship between income inequality and mortality, which employed several measures of income inequality, demonstrated that the median share measure is highly correlated with other measures of inequality such as the Gini coefficient and the coefficient of variation.[26] The specific details of the data for the individual countries are given below.

Australia

The population of Australia in 1991 was just over 17 million people with approximately 73% of the population of the country included in the MAs in this study. The 18 MAs for Australia were defined as urban centres (50,000 or more population) at the 1991 Census. Income inequality measures for Australian MAs were derived from the 1991 Census and adjusted by income data from the 1993–94 Household Expenditure Survey. This adjustment is necessary as the Census does not include the total income received by those in the top income range (i.e., >$150,000). The mortality data were obtained from Australian Bureau of Statistics death registrations and are based on 3-year averages (1990–1992) by MAs for working-aged adults between 25 and 64 years of age.

Canada

The population of Canada in 1991 was just over 28 million people with approximately 63% of the population of the country included in the MAs in this study. Income inequality measures for Canadian MAs were derived from a specially prepared micro data file of the entire 2B sample of the 1991 Census of Population. The 2B sample represents information gathered from 20% of Canadian households who responded to the long-form questionnaire, which includes detailed information about sources of household income. The mortality data were obtained from Statistics Canada's vital statistics and are based on 3-year averages (1990–1992) by MA for working-aged adults between 25 and 64 years of age.

Great Britain

The population of Great Britain in 1991 was just over 56 million people with the entire population being allocated to one of the 135 major "functional cities" and their hinterlands, all with populations in excess of 50,000. The functional cities were defined to encompass populations to maximize the number of people living and working within the same area.[27] Income inequality statistics were estimated by imputing the incomes of individual households as recorded by the 1991 Census by using household income measures taken during the first wave of the British Household Panel Study during 1991 and 1992; and variables recorded in common by both the census and the survey. The distribution of household incomes in each area in 1991 was then compared with the income distributions studied in an analysis of 20% of bank accounts in England and Wales in 2002 and found to be strongly related ($r = 0.76$). Working-age mortality data were provided by the Office of

National Statistics and the Registrar General for Scotland for 1990–1992 and aggregated to the functional city level.

Sweden

The Swedish population in 1991 was 8.6 million people with approximately 50% of the total population living in the 40 Swedish MAs included in this study. These were the MAs in Sweden where the population exceeded 50,000 inhabitants in 1991. The income inequality measure for this study was derived from Sweden's Total Enumeration Income Survey (1991) which contained information about economic circumstances for all households. Mortality data were obtained from the National Board of Health and Welfare for 1990–1992.

United States

In 1990, the population of the United States was over 248 million people with almost 78% resident in 283 MAs. In total, 282 MAs of the United States were included in these analyses (mortality data were not available for Anchorage, Alaska). Income inequality measures for the US MAs were derived from a special tabulation of the full one in six samples of the 1990 Census, also commonly known as the long form, which asks detailed information on income sources. Data files contained 32 income categories with the highest category representing household incomes greater than $250,000. Metropolitan areas mortality rates for the United States were calculated from the National Centre for Health Statistics Compressed Mortality Files for 1989–1991.

METHODS

The unadjusted relationship between income inequality and mortality was examined by using both weighted (by the square root of the population size) and unweighted bivariate linear regression analyses and weighted analysis of variance (ANOVA). The ANOVA models considered the effects on working-age mortality of income inequality, a country-indicator variable, MA population quartiles, and their two–way interactions. Weighting is appropriate when it is known in advance that there is unequal variability in the observations and, therefore, that some data points will contribute more to the overall fit of the data than others.[28,29] In this case, the smaller MAs have greater variability in working-age mortality rates than the larger MAs. The square root of the population size becomes the vector of weights which are inversely proportional to the variances of the individual observations. In diagnostic analyses of residuals, using the square root of the population size as the weight vector produced the best fit, as assessed by plots of fitted values versus residuals. We also include the unweighted results for the regression modelling given that one could make the argument that weighting may not appropriate in ecological analyses where every place, effectively, should count equally in the regression model.

RESULTS

Descriptive Statistics

There are 528 MAs in five countries in this study (Table 1). The minimum MA population size for this study was just below 50,000, with the largest average MA population sizes in the United States. Average metropolitan scale income inequality was the

TABLE 1. Descriptive statistics

Country	N	Population	Median share	Working-age mortality (rate per 100,000)
All	528			
Mean		541,441	0.022	358
Minimum		49,771	0.154	195
Maximum		18,087,251	0.272	571
Standard deviation		13,821,52	0.019	67
Australia	18			
Mean		701,667	0.238	297
Minimum		60,067	0.223	218
Maximum		3,672,855	0.267	426
Standard deviation		1,071,959	0.011	47
Canada	53			
Mean		356,437	0.235	301
Minimum		50,193	0.216	244
Maximum		3,893,046	0.262	400
Standard deviation		696,601	0.010	35
Great Britain	135			
Mean		416,343	0.226	366
Minimum		49,771	0.200	253
Maximum		12,823,814	0.254	528
Standard deviation		1,172,578	0.012	54
Sweden	40			
Mean		107,590	0.249	266
Minimum		51,217	0.203	195
Maximum		679,644	0.272	347
Standard deviation		113,714	0.015	37
United States	282			
Mean		687,410	0.209	382
Minimum		56,735	0.154	237
Maximum		18,087,251	0.249	571
Standard deviation		1,643,829	0.016	62

highest (i.e., the average median share score was the lowest) in the United States (.209), followed by Great Britain (.226), Canada (.235), Australia (.238), and Sweden (.249). Metropolitan-area scale working-age mortality rates followed this same trend with the highest mean mortality rates being found in the United States at 381 deaths per 100,000, followed by Great Britain (366), Canada (301), Australia (296), and Sweden (266).

Regression Analysis

The relationship between median share of income and mortality for all of the MAs is depicted in the Figure. For the 528 MAs across the five countries, there was a strong statistically significant relationship between the median share of income and working-age mortality (Table 2). A hypothetical increase of 1% in the share of income to the poorest half of households was associated with a decline in working-age mortality rate of over 21 deaths per 100,000 in the weighted analysis and 19 deaths per 100,000 in the unweighted analysis. The median share variable alone

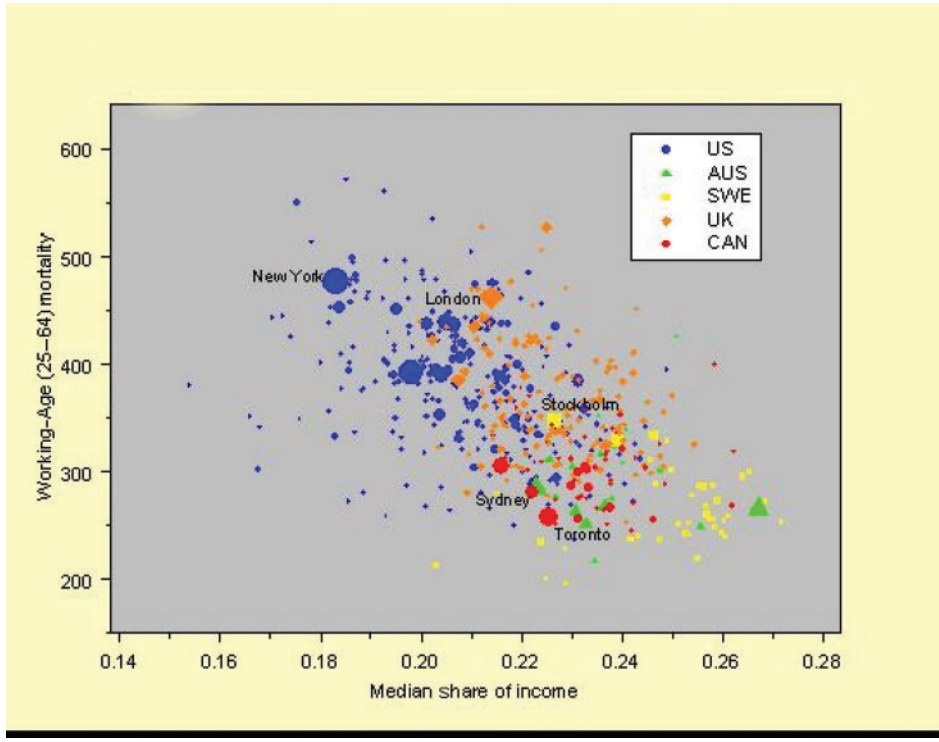

FIGURE. Working-age mortality by median share of household income in Australian, British, Canadian, Swedish, and US metropolitan areas (MAs), 1990–1991.

accounted for 34% of the variation in mortality rates across the 528 MAs (32% in the unweighted analysis).

This overall relationship was led by the 417 or 79% of MAs which were from the United States and Great Britain. The relationship between median share of income and working-age mortality was statistically significant for both American and British MAs ($P < .01$), with the median share variable accounting for 19% and 15%, respectively, of the variation in working-age mortality within each of the countries. There was no relationship between metropolitan median share of income and working-age mortality within Australia, Canada, or Sweden.

TABLE 2. Summary of regression results

Metropolitan area grouping	N	Median share coefficient (weighted)	R^2	Median share coefficient (unweighted)	R^2
All	528	−21.13*	.34	−19.45*	.32
Australia	18	−2.27	.01	4.13	.01
Canada	53	−1.18	.00	−1.74	.00
Great Britain	135	−18.29*	.15	−16.30*	.13
Sweden	40	0.03	.00	4.19	.03
United States	282	−18.50*	.23	−16.76*	.19

*$P < .01$.

Analysis of Variance

In ANOVA models of working-age mortality, we found significant main effects for income inequality ($F=279.03$, $P<.01$), the country indicator ($F=9.14$, $P<.01$) and metropolitan are population quartile ($F=3.54$, $P=.01$). We also found a modest effect for the interaction between income inequality and population size ($F=2.53$, $P=.06$) suggesting that the effect of income inequality on mortality is larger for the most populous cities.

DISCUSSION

This study has provided an important graphical representation of the relationship between the share of income belonging to the poorer half of the income distribution and working-age mortality across 528 MAs in five countries. Income inequality alone was able to account for 34% of the variation in working-age mortality rates across MAs in the various countries. The rank ordering by country of the average urban income inequality and mortality was, furthermore, evidence of a patterning of mortality by income distribution in urban areas in industrial economies. Although we do not dispute that mortality patterns are almost always more complicated than a single variable explanation, there are persuasive arguments to suggest that income inequality may be a useful marker for a range of other social and economic processes operating at the population scale which may be influential upon health.[30–32]

Using the MA as the unit of analysis across countries is perhaps one of the most useful and revealing scales at which to examine the population health effects of inequality. Cross-national studies almost exclusively compare overall inequality and mortality rates, even though the within-country variation in those values can often exceed the between-country variation. This approach allows us to compare more cities in the industrialized world on their record of income distribution and a measure of overall population health. Although no one would dispute the powerful influence of nation-states to set policies that affect overall income distributions and therefore of the caution that must be exercised in interpreting the pooled data, it is at the metropolitan scale that processes of social and economic differentiation caused by inequalities inherent in labour and housing markets are generally experienced by individuals. It is also the scale at which the redistributive impacts of unpriced positive (e.g., parks) and negative (e.g., crime or violence) externalities are experienced[33,34] and the scale at which governments provide health resources in the form of public goods and services that support everyday living conditions and the "epidemiology of everyday life."[32] Metropolitan areas with very fragmented local governance structures, for example, may not be able to do anything about inequality generated by unpriced externalities and this may be one contributor to the differences seen between MAs in the United States and Great Britain and the MAs in Australia, Canada, and Sweden.

On average, the most unequal MAs were found in the United States and Great Britain and the strongest effect of income inequality was registered for the largest MAs. A similar finding was reported in the British study of income inequality and self-rated health where the largest urban areas within Britain had the highest inequality and highest mortality rates.[19] Arguably, the kinds of variations in life circumstances and urban processes that one finds in the largest cities throughout the world are likely important candidates for further study in research aimed at explaining cross-national and cross-metropolitan patterns of population health.

It was within the United States and Great Britain that the relationship between income inequality and working-age mortality held. The within-country relationship did not hold for Australia, Canada, or Swedish MAs. This finding is suggestive of different configurations of other socially patterned health enhancing resources or exposures across the countries. Many of these resources likely filter down to MAs through national level social spending on public goods like education, health care, and housing. Amongst the countries examined here, public expenditure as a proportion of gross domestic product was the highest for Sweden in 1990 at about 31% and the lowest for the United States at just over 13%.[35] Clearly the identification of a relationship between inequality and mortality within the United States and Great Britain, and the absence for Australia, Canada, and Sweden, provides some evidence for the idea that there is no necessary association between income inequality and population health.[36–38] The question for the future thus becomes one of understanding the social conditions under which income inequality is linked with population health.

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